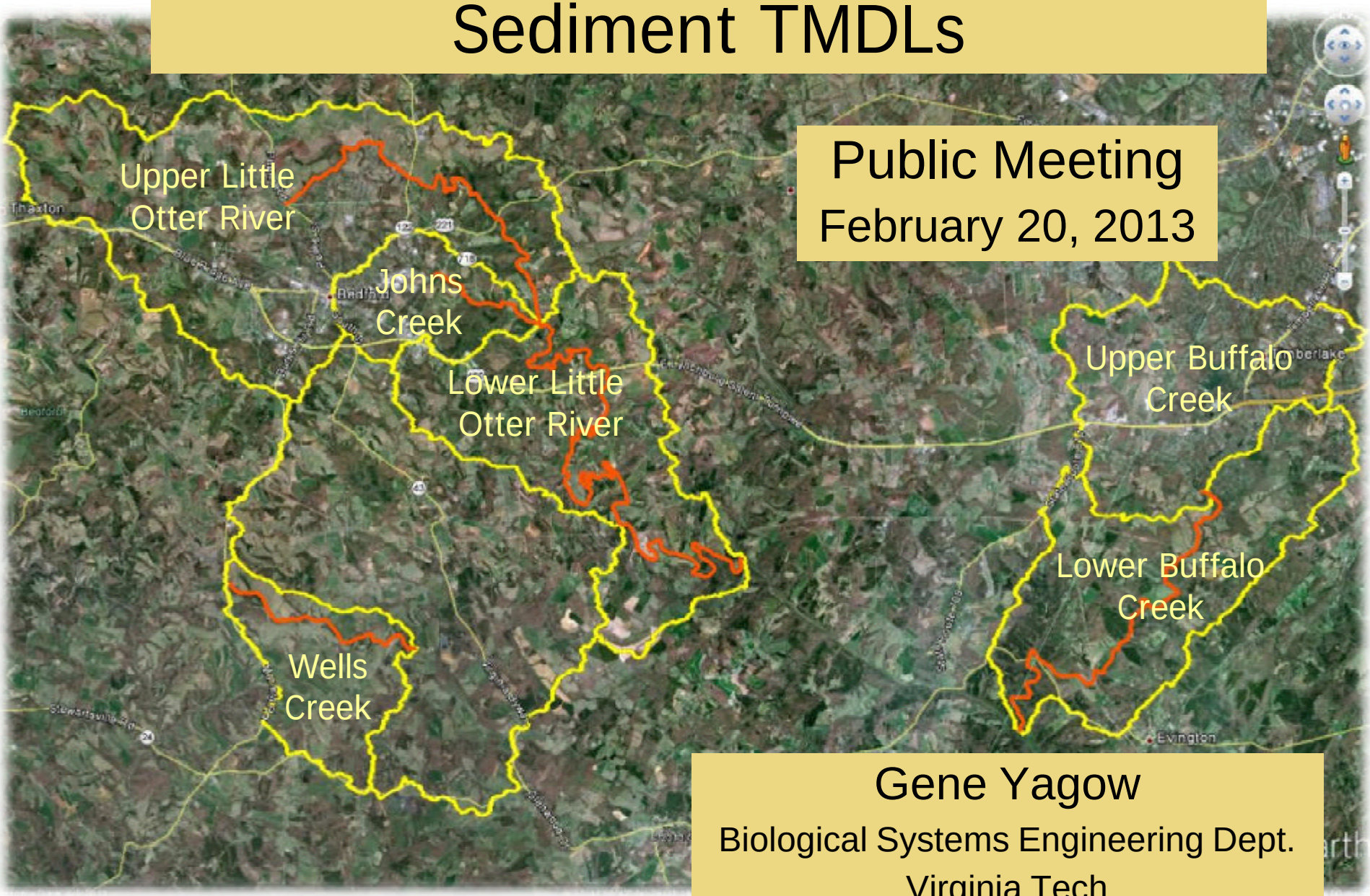
Little Otter River and Buffalo Creek Sediment TMDLs



Public Meeting

February 20, 2013

Gene Yagow

Biological Systems Engineering Dept.

Virginia Tech

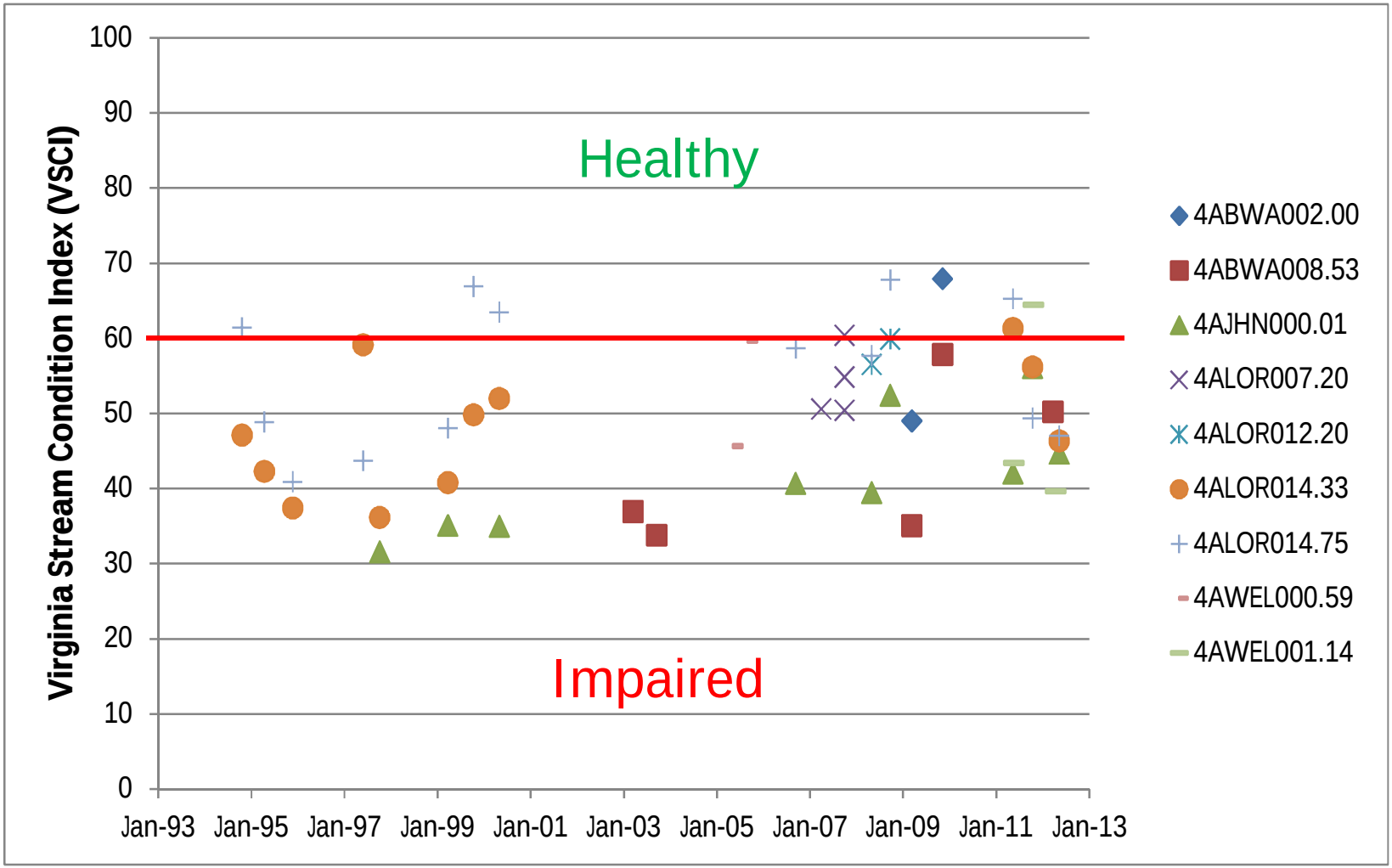
Total Maximum Daily Load (TMDL)

- A pollution budget that quantifies the maximum amount of pollutant that will allow the stream to be fully supportive of its designated uses.
- TMDL = WLA + LA + MOS
  - WLA = load from permitted sources
  - LA = load from non-point sources
  - MOS = margin of safety

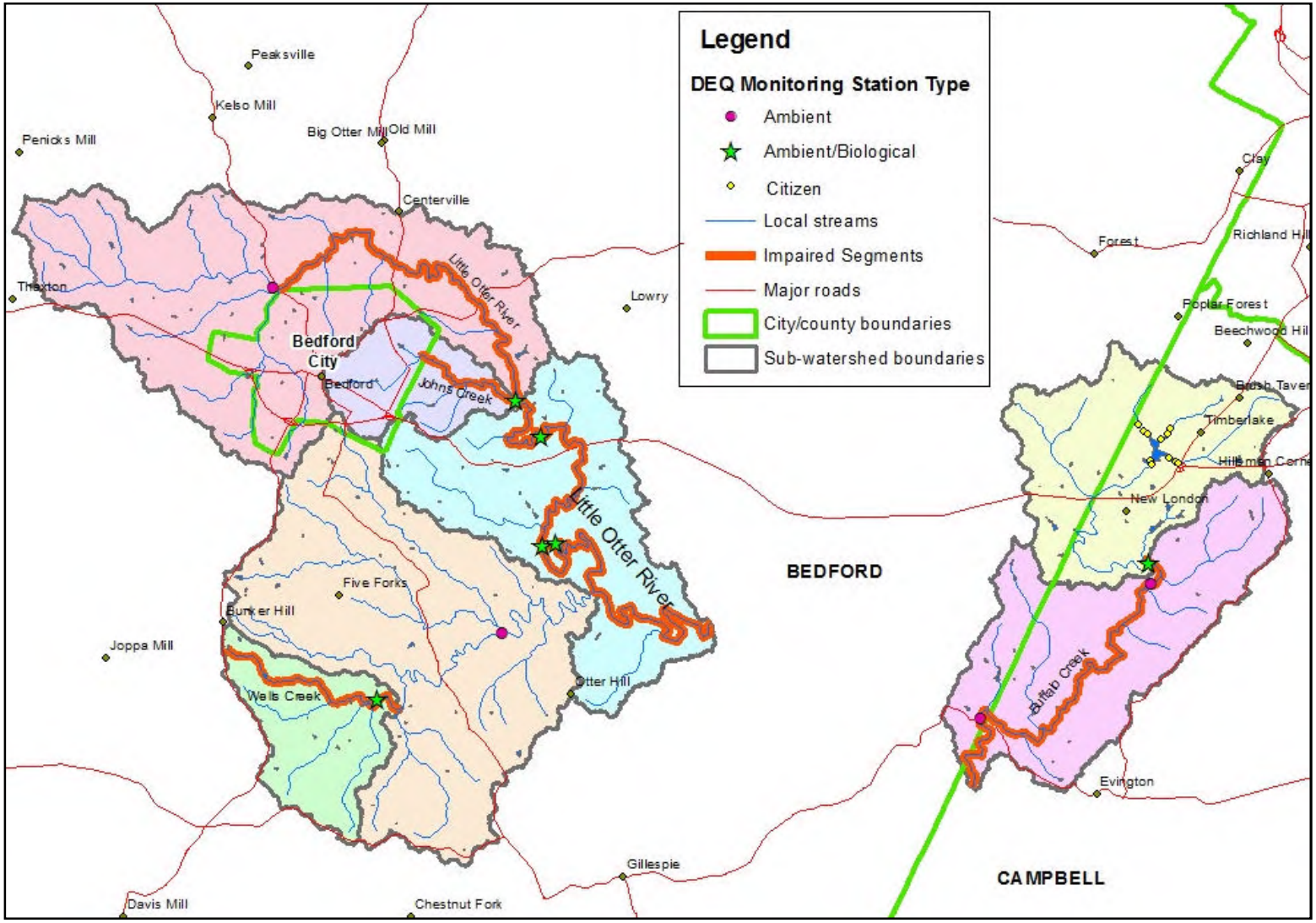
Overview

- Impairment
- Stressor Analysis
- Watershed characterization
- GWLF sediment modeling
- Setting TMDL endpoints (and MOS)
- WLA and LA
- Allocation Scenarios

Benthic Impairments



Impaired Segments



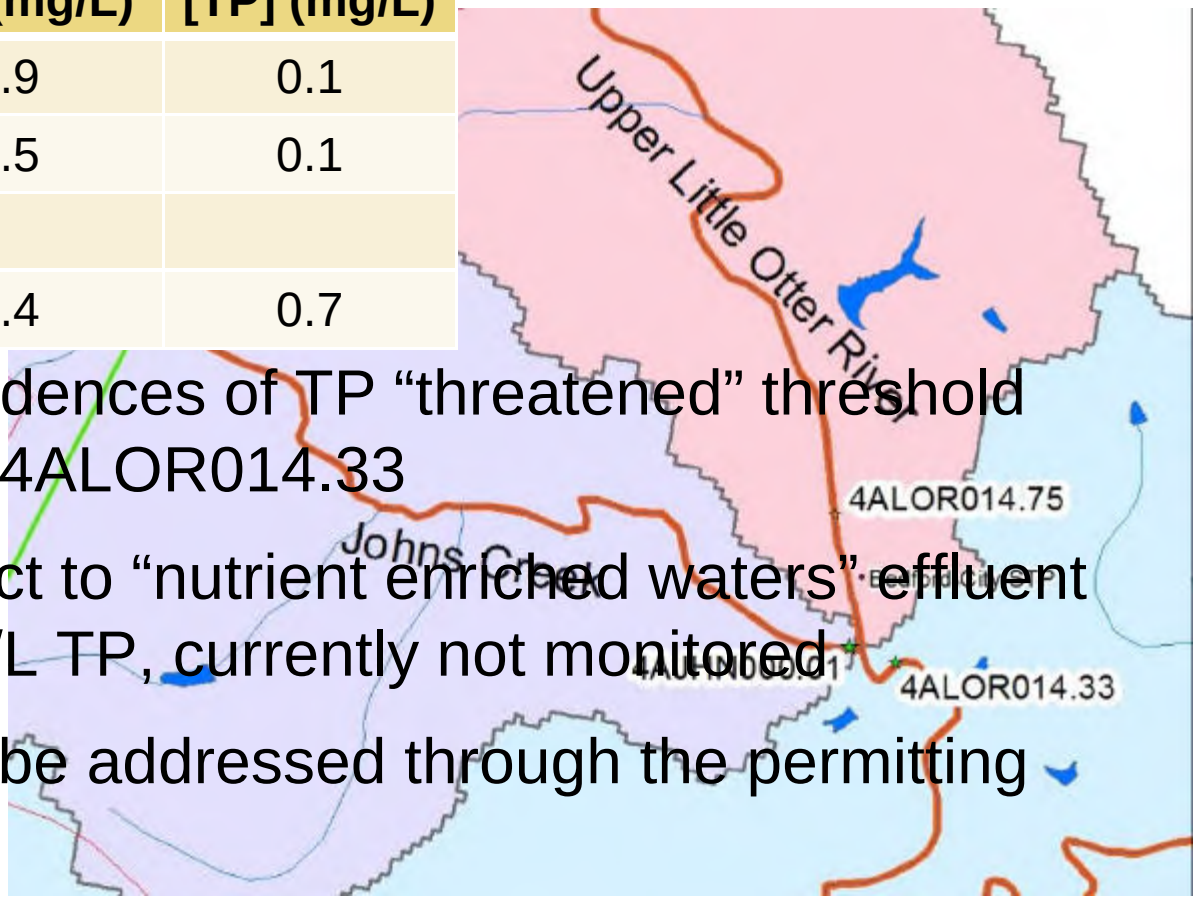
Stressor Analysis Results

- Little Otter River (6)
  - Upper Little Otter River (1): Sediment
  - Johns Creek (1): Sediment
  - Wells Creek (1): Sediment
  - Lower Little Otter River (3):
    - Sediment
    - Nutrients
- Buffalo Creek (2): Sediment

Lower Little Otter River Nutrient Impairment

- Nutrients diagnosed as a most probable co-stressor

Station	Average [TN] (mg/L)	Average [TP] (mg/L)
4ALOR014.75	0.9	0.1
4AJHN000.01	0.5	0.1
Bedford City WWTP		
4ALOR014.33	3.4	0.7



- Frequent exceedences of TP “threatened” threshold of 0.20 mg/L at 4ALOR014.33
- WWTP is subject to “nutrient enriched waters” effluent limits of 2.0 mg/L TP, currently not monitored
- Impairment will be addressed through the permitting process.

WATERSHED CHARACTERIZATION

Watershed characterization

- Current Land Use refinements
  - Distribution of pasture and hay acreages
  - Definition of disturbed or construction areas
- BMP representation
- Future Land Use

BMP representation

- Implemented BMPs were obtained from:
  - DCR BMP Agriculture Cost-Share Database
  - Peaks of Otter SWCD (Big Otter River Implementation Plan)
- BMPs were represented by their effect on sediment
  - Land use change
  - Upland filtering by buffers
  - Load reduction efficiency

Simulating Future Land use

- Analysis of population and local zoning

Sub-watershed	**10-yr Population change**	Total Area (acres)	Agland zoned for Development			Forest zoned for Development			**Assigned Future Ag Reduction**	**Assigned Future Forest Reduction**	Rationale
			Bedford County (acres)	Bedford City (acres)	**Potential Future Ag Reduction**	Bedford County (acres)	Bedford City (acres)	**Potential Future Forest Reduction**			
Buffalo Creek - Lower	**12.60%**	1,538.4	69.4	0.0	**4.5%**	147.7	0.0	**9.6%**	**5.0%**	**20.0%**	estimated as 2x the forest change% in Upper BWA + availability of small parcels*
Buffalo Creek - Upper	**10.40%**	2,941.0	0.0	0.0	**0.0%**	0.0	0.0	**0.0%**	**0.0%**	**10.0%**	used pop change% + availability of small parcels*
Johns Creek	**-1.70%**	2,680.6	125.9	174.7	**11.2%**	275.3	251.0	**19.6%**	**11.0%**	**20.0%**	estimated as % zoning change
Little Otter River - Lower	**22.90%**	8,906.8	92.4	9.9	**1.1%**	134.3	8.0	**1.6%**	**1.0%**	**2.0%**	estimated as % zoning change
Little Otter River - Upper	**17.90%**	14,696.4	1,790.3	565.3	**16.0%**	1,502.5	572.3	**14.1%**	**16.0%**	**14.0%**	estimated as % zoning change
Machine Creek	**5.20%**	14,166.3	420.0	12.9	**3.1%**	276.5	14.5	**2.1%**	**3.0%**	**2.0%**	estimated as % zoning change
Wells Creek	**22.80%**	3,560.7	0.0	0.0	**0.0%**	0.0	0.0	**0.0%**	**0.0%**	**0.0%**	all zoned agriculture - unlikely future change

Campbell County was assessed visually through their on-line GIS.

* - Many parcels already sub-divided into small parcels in the Buffalo Creek watershed, suitable for development.

- Each agriculture and forest land use category reduced by the same %
- Each developed land use increased proportionately

GWLF SEDIMENT MODELING

GWLF Model

- Continuous simulation watershed model
- NPS sediment simulated from land uses and channel erosion
- PS sediment calculated from monitored data
- Hydrology was calibrated for the neighboring Big Otter River, and adjustments applied to other watersheds
- Average annual sediment load, 1992 - 2010

GWLF Sediment Loads

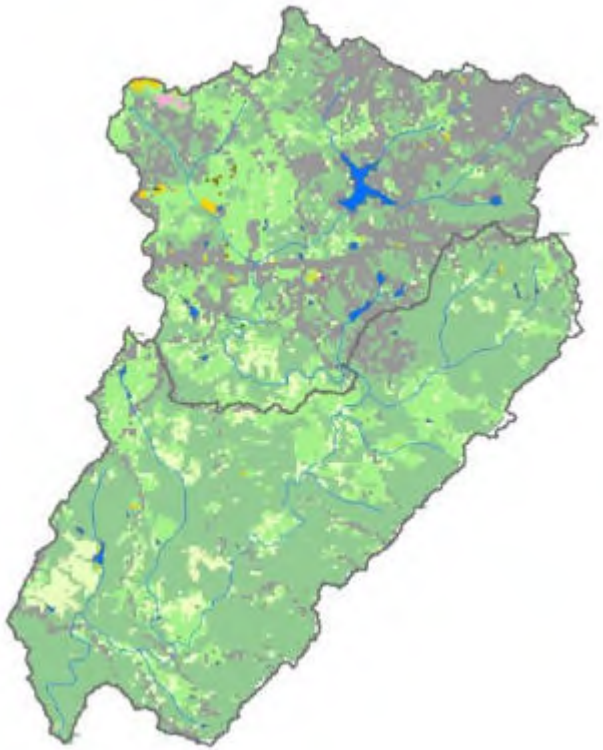
Land Use/Source Categories	Lower Buffalo Creek	Upper Buffalo Creek	Lower Little Otter River	Machine Creek	Wells Creek	Johns Creek	Upper Little Otter River
	Sediment Load (tons/yr)						
HiTill Rowcrop (hit)	12.2	44.7	96.7	76.1	1.8	4.7	8.0
LoTill Rowcrop (lot)	2.1	7.7	92.2	72.9	1.7	4.5	7.7
Pasture (pas_g)	24.7	9.4	65.8	28.9	32.5	3.1	53.4
Pasture (pas_f)	869.2	332.0	2,368.4	1,078.4	1,060.2	109.8	1,887.9
Pasture (pas_p)	492.6	192.1	1,363.3	622.1	608.8	63.9	1,087.7
Riparian pasture (trp)	1,124.3	436.8	3,320.7	1,551.4	1,385.5	144.0	2,576.1
AFO (afo)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Hay (hay)	298.0	145.1	1,259.1	782.2	308.5	52.0	689.1
Forest (for)	145.8	26.8	184.4	98.6	18.9	16.4	97.6
Harvested forest (hvf)	13.4	2.5	16.2	8.9	1.7	1.5	8.9
Transitional (barren)	259.7	169.2	152.6	53.4	11.9	59.6	165.6
Pervious LDI (pur_LDI)	76.8	163.6	198.8	102.9	23.8	95.1	299.3
Pervious MDI (pur_MDI)	0.2	4.6	1.6	0.3	0.0	7.9	8.6
Pervious HDI (pur_HDI)	0.0	0.4	0.0	0.0	0.0	1.1	0.9
Impervious LDI (imp_LDI)	9.0	16.8	40.3	6.6	0.7	9.7	30.3
Impervious MDI (imp_MDI)	10.4	26.5	47.3	0.7	0.0	26.7	38.8
Impervious HDI (imp_HDI)	2.2	4.9	13.6	0.2	0.0	10.0	8.5
Channel Erosion	30.2	14.3	306.4	38.4	2.7	6.4	55.4
Point Sources	0.0	0.0	0.0	0.0	0.0	0.0	11.6
Total Sediment Load	**3,370.8**	**1,597.4**	**9,527.3**	**4,522.1**	**3,458.8**	**616.3**	**7,035.3**
Total Future Sediment Load	3,672.4	1,632.0	9,526.5	4,397.5	3,458.8	615.9	6,395.5
Difference	**301.6**	**34.6**	**-0.8**	**-124.6**	**0.1**	**-0.4**	**-639.9**

SETTING THE TMDL ENDPOINTS (AND MOS)

Basis for Setting Sediment Endpoints

- Biology: Aquatic Life Use standard
  - Virginia Stream Condition Index (VSCI) = 60
- Sediment: No in-stream WQ standard
- Relationship between sediment and the in-stream biology
- Measures:
  - Biology = VSCI
  - Sediment = All Forest Load Multiplier

All Forest Load Multiplier (AllForX)

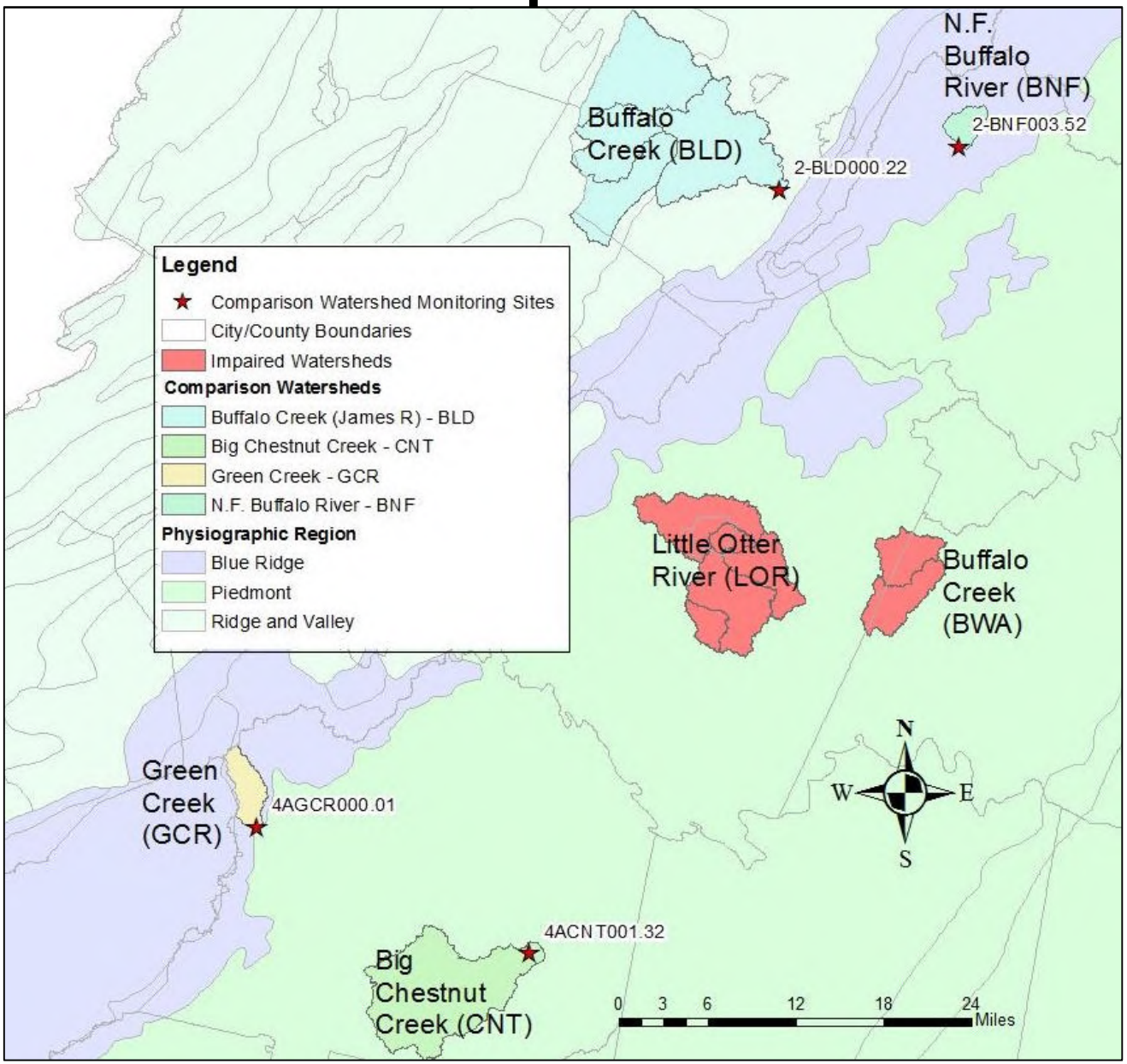


Existing Condition

All Forest Condition

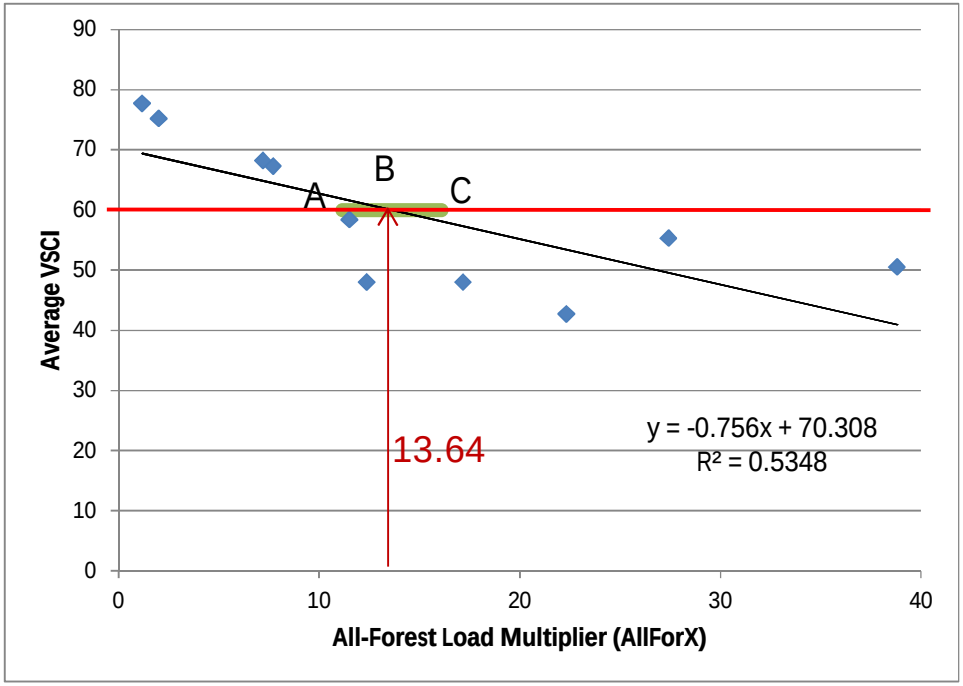
$$\text{AllForX} = \frac{\text{Existing Load}}{\text{All Forest Load}}$$

Impaired and Comparison Watersheds



AllForX Regression

Land Use/Source Categories	Impaired Watersheds						Comparison Watersheds			
	Lower Buffalo Creek	Upper Buffalo Creek	Lower Little Otter River	Wells Creek	Johns Creek	Upper Little Otter River	BLD	BNF	CNT	GCR
	Sediment Load in tons/yr									
Existing Sediment Load	3,370.8	1,597.4	9,527.3	3,458.8	616.3	7,035.3	24,801.8	472.6	7,982.0	983.3
All-Forested Sediment Load	292.4	71.5	769.1	89.1	35.8	256.4	0.0	3,210.9	398.6	1,106.4
AllForX = Existing Load/All Forest Load	**11.5**	**22.3**	**12.4**	**38.8**	**17.2**	**27.4**	**7.7**	**1.2**	**7.2**	**2.0**



B = AllForX value used for the TMDL;

AC = the 80% Confidence Interval (shown in green);

TMDL = $AllForX_B$ x All-forest load;

MOS = ($AllForX_B$ – $AllForX_A$) x All-forest load.

AllForX Derivation of TMDLs and MOSs

Land Use/Source Categories	Lower Buffalo Creek	Upper Buffalo Creek	Lower Little Otter River	Wells Creek	Johns Creek	Upper Little Otter River
	Sediment Load in tons/yr					
Future Sediment Load	3,672.4	1,632.0	9,526.5	3,458.8	615.9	6,395.5
All-Forested Sediment Load	292.4	71.5	769.1	89.1	35.8	256.4
TMDL Load (AllForX = 13.64)	**3,987.4**	**974.8**	**10,487.3**	**1,214.7**	**488.8**	**3,496.4**
Margin of Safety (MOS)*	**721.3**	**176.3**	**1,897.0**	**219.7**	**88.4**	**632.5**
MOS as % of TMDL	18.1%	18.1%	18.1%	18.1%	18.1%	18.1%
Allocation Load (TMDL - MOS)	**3,266.1**	**798.5**	**8,590.3**	**995.0**	**400.4**	**2,864.0**
% Reduction from Future Load:	11.1%	51.1%	9.8%	71.2%	35.0%	55.2%

* MOS = ($AllForX_{13.64}$ - $AllForX_{11.17}$) * All-Forest Load

WLA AND LA

Permits included in WLAs

VPDES Permits with Monitoring Requirements

Facility Name	Permit Number	Permit Type	Receiving Stream
Body Camp Elementary School	VA0020818	VPDES	Wells Creek
Bedford City - WWTP	VA0022390	VPDES	Upper Little Otter River
Bedford City - WTP	VAG640066	General	Upper Little Otter River UT
Bedford Ready Mix Concrete	VAG110014	Concrete	Johns Creek

Industrial Storm Water General Permits (ISWGP)

Facility Name	VPDES Permit Number	Source Type	Receiving Stream
Sam Moore Furniture LLC	VAR050528	ISWGP	Johns Creek
Hilltop Lumber Co Inc	VAR050544	ISWGP	Upper Little Otter River
Rubatex International LLC	VAR050733	ISWGP	Johns Creek
Bedford County - Sanitary Landfill	VAR051233	ISWGP	Machine Creek UT
Bedford City - Hylton Site	VAR051369	ISWGP	Johns Creek
Central VA Pallet and Stake Co	VAR052107	ISWGP	Upper Little Otter River
New London Auto Parts Inc	VAR051801	ISWGP	Lower Buffalo Creek

Construction Permits

MS-4 Permits

VPDES Permit Number	Receiving Stream
Virginia DOT VA040115	Upper Buffalo Creek

Future Growth WLA

- Construction – included as a % of all developed areas
- WWTP – 50% of current design flow
- All other permitted WLAs:
  - 2x existing WLAs
  - Minimum of 1% of TMDL

Detailed TMDL Components

Impairment	TMDL	WLA		LA	MOS
	(tons/yr)				
Lower Buffalo Creek	3,987.4	11.45		3,254.6	721.3
		VAR051801 New London Auto Parts Inc	3.64 tons/yr		
		construction aggregate WLA	0.53 tons/yr		
		Future Growth WLA	7.28 tons/yr		
Upper Buffalo Creek	974.8	22.99		775.4	176.3
		VAR040115 Virginia DOT MS-4 WLA	6.95 tons/yr		
		construction aggregate WLA	2.13 tons/yr		
		Future Growth WLA	13.91 tons/yr		
Lower Little Otter River	10,487.3	34.50		8,555.9	1,897.0
		VAR051233 Bedford County - Sanitary Landfill	11.22 tons/yr		
		construction aggregate WLA	0.84 tons/yr		
		Future Growth WLA	22.45 tons/yr		
Upper Little Otter River	3,496.4	158.23		2,705.7	632.5
		VA0022390 Bedford City - WWTP	91.38 tons/yr		
		VAG640066 Bedford City - WTP	1.51 tons/yr		
		VAR050544 Hilltop Lumber Co Inc	2.56 tons/yr		
		VAR052107 Central VA Pallet and Stake Co	2.53 tons/yr		
		construction aggregate WLA	1.36 tons/yr		
		Future Growth WLA	58.89 tons/yr		
Johns Creek	488.8	32.12		368.3	88.4
		VAG110014 Bedford Ready Mix Concrete	0.33 tons/yr		
		VAR050528 Sam Moore Furniture LLC	4.32 tons/yr		
		VAR050733 Rubatex International LLC	1.57 tons/yr		
		VAR051369 Bedford City - Hylton Site	4.32 tons/yr		
		construction aggregate WLA	0.53 tons/yr		
		Future Growth WLA	21.06 tons/yr		
Wells Creek	1,214.7	1.40		993.6	219.7
		VA0020818 Body Camp Elementary School	0.1 tons/yr		
		construction aggregate WLA	0.09 tons/yr		
		Future Growth WLA	1.21 tons/yr		

ALLOCATION SCENARIOS

Allocation Scenarios - Buffalo Creek

Upper Buffalo Creek

Land Use/ Source Group	Future Sediment Load (tons/yr)	Scenario 1		Scenario 2	
		% Reduction	Load	% Reduction	Load
Row Crops	52.4	52.1%	25.1		52.4
Pasture	970.4	52.1%	464.5	60.2%	385.9
Hay	145.1	52.1%	69.4		145.1
Forest	24.1		24.1		24.1
Harvested Forest	2.2	52.1%	1.1		2.2
Developed	413.3	52.1%	197.8	60.2%	164.3
Channel Erosion	15.4	52.1%	7.4		15.4
Permitted WLA	9.1		9.1		9.1
Total Load	1,632.0		**798.5**		**798.5**
Target Allocation Load	**798.5**				
% Reduction Needed :	51.1%				

Lower Buffalo Creek

Land Use/ Source Group	Future Sediment Load (tons/yr)	Scenario 1		Scenario 2	
		% Reduction	Load	% Reduction	Load
Row Crops	13.9	11.4%	12.3		13.9
Pasture	2,407.3	11.4%	2,131.7	13.1%	2,092.7
Hay	284.8	11.4%	252.2		284.8
Forest	118.4		118.4		118.4
Harvested Forest	10.9	11.4%	9.7		10.9
Developed	702.6	11.4%	622.2	13.1%	610.8
Channel Erosion	130.5	11.4%	115.5		130.5
Permitted WLA	4.2		4.2		4.2
Total Load	3,672.4		**3,266.1**		**3,266.1**
Target Allocation Load	**3,266.1**				
% Reduction Needed :	11.1%				

Allocation Scenarios – Upper Little Otter River

Upper Little Otter River

Land Use/ Source Group	Future Sediment Load (tons/yr)	Scenario 1		Scenario 2	
		% Reduction	Load	% Reduction	Load
Row Crops	13.2	56.8%	5.7		13.2
Pasture	4,706.9	56.8%	2,031.2	63.6%	1,715.0
Hay	578.7	56.8%	249.7		578.7
Forest	83.9		83.9		83.9
Harvested Forest	7.7	56.8%	3.3		7.7
Developed	848.9	56.8%	366.3	63.6%	309.3
Channel Erosion	56.9	56.8%	24.5		56.9
Permitted WLA	99.3		99.3		99.3
Total Load	6,395.5		**2,864.0**		**2,864.0**
Target Allocation Load	**2,864.0**				
% Reduction Needed :	55.2%				

Johns Creek

Land Use/ Source Group	Future Sediment Load (tons/yr)	Scenario 1		Scenario 2	
		% Reduction	Load	% Reduction	Load
Row Crops	8.1	36.4%	5.2		8.1
Pasture	285.4	36.4%	181.5	40.9%	168.7
Hay	46.3	36.4%	29.4		46.3
Forest	13.1		13.1		13.1
Harvested Forest	1.2	36.4%	0.8		1.2
Developed	241.6	36.4%	153.6	40.9%	142.8
Channel Erosion	9.2	36.4%	5.9		9.2
Permitted WLA	11.1		11.1		11.1
Total Load	615.9		**400.4**		**400.4**
Target Allocation Load	**400.4**				
% Reduction Needed :	35.0%				

Allocation Scenarios – Lower Little Otter River

Wells Creek

Land Use/ Source Group	Future Sediment Load (tons/yr)	Scenario 1		Scenario 2	
		% Reduction	Load	% Reduction	Load
Row Crops	3.6	71.6%	1.0		3.6
Pasture	3,087.0	71.6%	875.8	78.9%	651.8
Hay	308.5	71.6%	87.5		308.5
Forest	18.9		18.9		18.9
Harvested Forest	1.7	71.6%	0.5		1.7
Developed	36.3	71.6%	10.3	78.9%	7.7
Channel Erosion	2.7	71.6%	0.8		2.7
Permitted WLA	0.2		0.2		0.2
Total Load	3,458.8		**995.0**		**995.0**
Target Allocation Load	**995.0**				
% Reduction Needed :	71.2%				

Lower Little Otter River

Land Use/ Source Group	Future Sediment Load (tons/yr)	Scenario 1		Scenario 2	
		% Reduction	Load	% Reduction	Load
Row Crops	193.8	10.0%	174.4		193.8
Pasture	7,019.9	10.0%	6,315.8	12.3%	6,155.0
Hay	1,223.6	10.0%	1,100.9		1,223.6
Forest	180.4		180.4		180.4
Harvested Forest	15.9	10.0%	14.3		15.9
Developed	578.7	10.0%	520.7	12.3%	507.4
Channel Erosion	302.2	10.0%	271.9		302.2
Permitted WLA	12.1		12.1		12.1
Total Load	9,526.5		**8,590.3**		**8,590.3**
Target Allocation Load	**8,590.3**				
% Reduction Needed :	9.8%				

Next Steps

- Public comment open for 30 days
- Finalize report and submit to EPA
- Begin Implementation Planning

Contact Information

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